DEPARTMENT OF AGRICULTURE AND STOCK.

The CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY
BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE, QUEENSLAND.

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Contents.

CONTROL OF INSECT PESTS OF CANE.
RESISTANCE OF S.J. 4 TO GRUBS.
DISEASE RESISTANCE TRIALS.
NEW VARIETIES IN SOUTHERN QUEENSLAND.
CONTROL OF GRUBS BY FUMIGATION.
RATOONING IN THE BURDEKIN DISTRICT.
CANE BORERS IN THE MACKAY DISTRICT.
NOTES ON WEED KILLERS.

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BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE

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CANE GROWERS'
QUARTERLY BULLETIN

ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 JULY, 1934

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CONTENTS.

	Page.
* The Control of Insect Pests of Sugar Cane, by R. W. Mungomery	1
Poona Pea as a Green Manure Crop in North Queensland	8
The Resistance of the Seedling S.J. 4 to Grub Damage in North Queensland	9
Disease Resistance Trials, by Arthur F. Bell	11
Permits Necessary for the Transfer of Cane Plants	12
New Cane Varieties in the Southern Districts, by H. W. Kerr ..	13
Experiments with White Arsenic as a Means of Controlling Grubs	15
* Control of Cane Grubs in North Queensland by Fumigation, by H. G. Knust	16
Care of Farm Machinery	18
Ratooning in the Burdekin District, by A. P. Gibson	19
The Parentage of P.O.J. 2725 and Co. 290	20
Cane Borers in the Mackay District, by W. A. McDougall	21
Early Effects of Fertilizer	22
Some Notes on Weed Killers	23

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The
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—Bulletin—

VOL. 2 | 1 JULY, 1934 | No. 1

The Control of Insect Pests of Sugar Cane.

By R. W. MUNGOMERY.

IN common with almost all other plants, sugar-cane is attacked by a number of insects, the combined effect of which tends to weaken the plant and prevent to a greater or less degree the full functioning of its roots, stalks, and leaves. Thus, to cite a few examples:—"White grubs" attack the roots and underground portions of the stalk, and deprive the cane stool of its means of maintaining its normal supply of plant foods and water. Borers feed on the more succulent internal fibres of the stalk and interfere with the ready circulation of sap between roots and leaves. At the same time the tunnels of these borers, having access to the outside air, provide an easy entrance for certain fungi which cause serious internal rots. Caterpillars and grasshoppers at times consume almost the entire leafblades which are the "factories" wherein the cane sugar is manufactured. Evidently, therefore, any serious attack by an insect results in a curtailment of the plant's activities, and this is automatically reflected in reduced crop yields. It is true that the effect of some insects found attacking cane is almost negligible, whilst others, although potentially dangerous, are never present in sufficiently large numbers to cause noticeable damage. However, when insects become so abundant as to compete seriously with man in his efforts to raise crops, they then become pests, and some form of control must be instituted against them to prevent or restrict their damage.

The fundamental principles of insect control can be considered from four main standpoints, and these will be reviewed in their possible application to the control of sugar-cane insect pests. Such control measures may be divided into what may broadly be termed (1) cultural, (2) chemical, (3) biological, and (4) legislative methods.

CULTURAL CONTROL.

Cultural methods of control are such that, by some variation of, or concentration on a particular farm practice, the agriculturist aims at constantly placing the insect pest at a disadvantage, and either minimises or completely counteracts its otherwise harmful effects. Cultural methods of control are those which have been gained from the common experience of man in his fight against the many insect pests found damaging his crops.

They may be classed as methods which usually readily suggest themselves and are more or less common knowledge, and for that reason they are most frequently put into operation to combat pests. Some of these farm practices may be summarised as follows:—

Summer Ploughing: It is well known that many soil frequenting insects are located in the upper soil levels during the warmer months of the year, whilst during the cold winter period they are found in a more or less inactive condition usually below plough level. Therefore, if ploughing be carried out during the summer, a much greater check is imposed on these insects than if the same operation were carried out during the winter.

Collecting and Hand-picking: The systematic collection of beetles from feeding trees in compact areas has generally been acknowledged to bring about a satisfactory reduction in the incidence of grubs during the following season; but in broken country, where collecting must of necessity be extensive and, at best, incomplete, the benefits to be derived from this practice are doubtful. In some of the Southern areas boys are employed to follow behind single-furrow ploughs and to collect any grubs that may be exposed in the furrows. Provided this work is carried out thoroughly, it is possible so to clean the land that two or three crops may be grown subsequently without any serious grub damage. These remarks apply of course to the grubs with the two year life cycle which is characteristic of the Childers cane grub.

Excision: This form of control is sometimes employed against moth borers in parts of the West Indies and Java where labour is cheap, but this rather tedious practice finds little favour in Queensland.

Field Sanitation: The elimination of weeds and grasses is a common agricultural practice which tends to reduce insect infestation, some pests being originally attracted by untidy overgrown fields. Such a measure directly reduces the breeding grounds of moth borers and many sap-sucking insects, such as aphids and leafhoppers, which are the natural transmitting agents of many virus diseases, and it indirectly prevents the rapid spread of these diseases. Mosaic disease of sugar-cane is a notable example of a disease whose spread is influenced in this way by the presence of grasses.

Variation of Planting Date: Early or late planting to avoid pest damage is a point frequently stressed. In the former case, the crop is past the susceptible stage, or matured, before the pest is capable of doing any appreciable harm; in the latter case, the pest is usually full grown and about to enter a quiescent stage of its cycle when the crop is planted, and similarly, serious damage is obviated. In North Queensland it is generally agreed that late-planted crops are less subject to bad grub attack than the taller early-planted crops. Around the Mackay district, wireworm damage is, to a point, less severe in late planted blocks than in those planted early. In South Queensland, autumn planting usually ensures a good strike and freedom from a number of pests, whilst spring planted cane frequently suffers damage.

Resistant Varities: Deep rooting varieties of sugar-cane such as some of the P.O.J. canes and D. 1135 are much more resistant to grub attack than are shallow rooting varieties such as Q. 813. Again, canes with a hard rind are less subject to rat and borer damage as compared with canes of the softer and more succulent types.

Burning of Cane Trash: This system is largely practised throughout Queensland, where it aids considerably in reducing the numbers of beetle borer, which would otherwise migrate to surrounding fields and commence new centres of infestation. It should always be borne in mind, however, that such practices simultaneously destroy the Tachinid parasite, and where this

fly is established burning of trash is not to be recommended as a form of borer control. The disposal of trash in this manner also tends to reduce the incidence of army worms, but again these may be successfully and economically controlled by the use of poison baits.

The Rotation of Crops: Crop rotation is a desirable form of control when dealing with insects which attack only one of the crops under rotation, but in Queensland, with the possible exception of a few of our minor cane pests, it is doubtful whether this measure would afford any relief from our more serious cane pests.

Mechanical Methods: The use of implements in the field has been developed to a greater extent in Queensland than in any other sugar-producing country, and it is not surprising that the idea of obtaining a high degree of insect control has been incorporated in the building of some of the machines which are used in the ordinary course of cultivation work. In this connection we refer to an improved rotary hoe with the rotor revolving at a high speed, pulverising the soil to a depth of 7-8 inches, and chopping the ground every 2 inches as the machine moves forward. With this implement a kill of 92 per cent. of the grubs present in the top 8-inch soil level has been obtained, and it is thought that with a few minor alterations, such as increasing the number of blades and thereby securing a finer cut, its efficiency might be even further increased. It is capable of treating 3 acres per 8 hours at a cost of approximately £1 per acre, and it has already resulted in a considerable saving in cleaning up grub-infested areas.

CHEMICAL CONTROL.

Chemical control consists essentially of the direct application of chemicals to kill insects, and naturally their use is governed largely by the relation between the cost of the chemical and its application, and the amount of profit that can be expected from the crop in question. Chemicals may be used as insecticides in the form of stomach poisons, contact poisons, or fumigants. In the case of poisons, the type of insecticide to be used depends chiefly on the mouthparts of the insect to be controlled; i.e., whether they are of the biting and chewing type such as those of grasshoppers and caterpillars, or whether they are of the suctorial type such as those of leafhoppers and aphids. Pests having chewing mouthparts are controlled by spraying or otherwise finely coating their food plant with some poisonous compound such as Arsenate of Lead or Paris Green, so that when feeding on these plants they consume a quantity of the toxic compound which ultimately result in their death. In America, when grub-proofing lawns and golf greens, it is customary to mix quantities of lead arsenate with the soil when the greens are being made, or subsequently as top dressings, and any soil insects which happen to ingest this soil are soon killed by this poison, which remains effective for many years. Insecticides are sometimes mixed with a carrier such as bran or sawdust to which attractive substances such as molasses and lemon juice are added, and the whole mixture broadcasted in areas where the pest has assumed importance. The well known bran poison bait is an example of a successful bait used to overcome army worm infestation.

Such methods are of no use in the case of insects with suctorial mouthparts, since they ingest juices from within the plant. They are usually controlled by means of a contact spray such as nicotine sulphate or various emulsified oils, all of which adversely affect their breathing organs and soon bring about death.

Fumigants are another popular form of control. In most cases they possess anæsthetic and asphyxiating properties, which act very rapidly on the vitality of the insects, causing paralysis, and if the insects are forced

to remain in this atmosphere they soon die. Fumigants to be used successfully must be used intelligently. For instance some, such as carbon bisulphide, are heavier than air and must be released above the insects which are to be controlled; others such as hydrocyanic acid are lighter and must be placed in such a position that the rising fumes will overpower the insects and cause their death.

Soil fumigation is one of the surest means of dealing with the greyback cane grub, in that the pest is attacked at the place where it will cause its greatest damage, and if fumigation be carried out whilst the grub is still in its early stages, the cane stool will suffer very little injury. In Queensland, it has been customary to use a mixture of carbon bisulphide and paradichlorbenzene as a fumigant for the control of the cane grub. This fumigant is injected into the soil by means of a Dank's or Vermorel Injector, a measured quantity being injected at each stroke of the plunger which is operated by pressure with the hand.

BIOLOGICAL CONTROL.

The forces of nature if left to themselves tend towards a state of balance, and no one plant or animal can continue to increase in over-whelming numbers for any great length of time. If an insect pest increases abnormally over a number of years, a host of forces attack it from all quarters, and soon reduce it to its former status. These forces consist in adverse weather conditions, diseases, parasitic and predaceous insects, birds and animals, etc. Man has no control over some of these forces, such as the weather conditions, but he is able to utilise some of the other agencies in the control of certain pests which have increased abnormally in different parts of the world. This form of control is usually referred to as "biological control" and is applicable chiefly to the control of foreign pests which have accidently gained entry into another country. Under such circumstances it is usual to search for the death factors which keep the insect in check in its original home, and having selected the parasite or parasites which are considered to be the most effective, these are bred artificially, freed of all hyperparasites, and introduced into the country where the pest is to be controlled. Biological control is an ideal form of control in that friendly organisms aid in the suppression of the pest without any concerted effort on the part of man other than that of providing suitable conditions for the develoment of the parasite. This form of control is most successful in insular areas such as Hawaii and Fiji, where the fauna is limited and where introduced insects are not subjected to attack from a vast array of hyperparasites, etc., with which they might have to contend in larger continental areas carrying a larger and more varied insect population. In Hawaii, the control of the sugar-cane leaf-hopper and the Anomola grub have been outstanding successes in biological control when other forms of control seemed futile and the sugar-cane industry of these islands was threatened with imminent extinction. These cases were amongst the earlier attempts to utilise biological control, and their brilliant success has done much to popularise this form of control. In more recent years the spectacular control of the Levuana Coconut Moth in Fiji, by a fly originally parasitic on the caterpillar stage of a closely related moth in the Federated Malay States, has been one of the greatest achievemnts in the biological control of an insect which threatened the existence of the coconut industry, and which defied almost all other means of control.

Within our own industry we have an excellent example of biological control in the suppression of the sugar-cane beetle borer by the Tachinid fly parasite. This borer pest, which is a native of New Guinea and the neighbouring islands, gained entry into Queensland in the early settlement

days when the sugar industry was being established. At that time indiscriminate introductions of cane were made from other countries without adequate quarantine restrictions, and it was in this way that the pest became established. In their native New Guinea the sugar-cane and its parasite had been associated for centuries and had attained a state of adjustment in which there appeared to be no danger of the pest increasing to such numbers as to become a serious menace to its host. On the other hand it quickly became apparent that in some of the wetter districts of North Queensland the borer, unless controlled in some way, would soon prevent the growing of all canes of the desirable soft, sweet types.

In seeking for a means of controlling this pest it was therefore natural that a search should be made for the probable parasites which restricted its numbers in New Guinea. This search was largely directed by the late Frederick Muir of the Hawaiian Experiment Station and soon led to the introduction of the Tachinid fly into Australia. This parasite has since been bred in large numbers by the Entomologists of the Bureau of Sugar Experiment Stations and has been liberated by them wherever the beetle borer has been found, and it now exercises a high degree of control over that pest where climatic and other conditions are favourable.

However, these brilliant economic successes do not present the whole picture of biological control of insect pests. In this phase of endeavour, perhaps more than any other, the path to successful achievement is strewn with the remains of optimistic attempts which have ended in abject failure. Biological control does not consist in rushing off to a foreign country, bringing back a number of parasites, and letting them loose upon the unsuspecting pest; to ensure the success of biological forms of control a whole complex of factors must be inter-dependently favourable. Such a project is not to be embarked upon light-heartedly, but only after the most mature consideration, since a false step may have most disastrous economic consequences through the upsetting of the whole biological balance. Therefore we will now review some of the conditions necessary for the effective operation of biological forms of control and, equally important, some of the reasons why it cannot be universally applied.

It will be evident that a parasite cannot entirely destroy its host (i.e., the species on which it completes its development) for with the gradual elimination of the host, and the increase of the parasite, a point is ultimately reached where the number of parasites is greater than the remaining hosts, with the result that many parasites fail to find a host for the development of their young, and these die without reproducing. Consequently a reduction in the number of parasites soon follows a reduction in host population, until there is reached a point of partial equilibrium whereat the pest does not increase greatly before a corresponding increase takes places in the number parasitised.

The limiting factors operating against the successful working of a parasite may be a question of climate, or the kind of crop infested by the pest, and upon this latter factor depends the parasite's ability to locate its host. In the large continental area of America over which the Japanese beetle has spread, we find that in certain districts a wasp parasite is the most efficient of the many introduced species, whilst in other parts a fly parasite contributes largely to its control. Reverting once more to the parasite of the beetle borer, we find that this fly is able to exercise its greatest degree of control in erect cane, whilst in cane that is lodging badly the fly is unable to penetrate the dense layer of trash in search of borer grubs, and therefore control becomes reduced. It is also interesting to note in this connection that Veitch found the parasite to work very efficiently in the rainy districts of

Fiji, whilst in the drier zones of the same island colonies of this fly parasite, which resulted from similar sized liberations, almost invariably died out. In Queensland we find that this parasite is favoured by similar conditions, and it is well established in the moister districts such as Babinda and South Johnstone, whilst its establishment in the drier areas has been more difficult and less permanent. During the coming years, it is proposed to attempt to overcome these difficulties by liberating many thousands of these flies in borer-infested localities; data will be collected on subsequent control, and in this manner it is hoped to gain a clear idea of the degree of control that can be expected, and to evaluate the limitations of the parasite under varying conditions.

Biological control of army worms is also an important illustration to Queensland growers, especially in view of the fact that from a knowledge of the degree of parasitism being suffered by the pest they are advised whether it is considered justifiable to bait the pest, or whether to take no further steps other than to allow the infestation to be cleaned up by parasites in the normal way. In certain seasons (for instance, 1932 in South Queensland) the pest has been very bad, and has threatened to ruin young ratoons wherever trash was conserved. In this particular year the droughty weather and the harsh winter had adversely affected the parasites, and the pest was able to breed up in large numbers practically unmolested. In late October the parasitism suffered amounted to only 10-15 per cent., and consequently bran poison baits had to be used to check their depredations. Hence the limitation of parasite control under a certain set of conditions will be apparent. However, during the past year in the same areas, larger fields of trash have been conserved, but a milder winter has been followed by a more rainy spring. Army worm damage has been very light—certainly insufficient to warrant extensive artificial control measures being instituted against them, and the parasites have been able to cope with the pest in an entirely satisfactory manner.

The most recent attempt of the Bureau to bring about biological control by means of introduced parasites has been directed against the Isis cane grub in South Queensland. For this purpose a Dexiid fly has been introduced from Canada on two occasions during the past two years. In Canada, this fly normally attacks a grub very closely allied to our cane pest. Small isolated fertile areas, such as the Isis district, surrounded by tracts of less fertile forest country, and which carry an insect fauna totally different from the surrounding one, have been likened to islands and are termed biological islands. It is thought that an introduced parasite, if once established, might become more efficient under such circumstances and less liable to suffer attack from insect parasites than if the same insect were introduced into a large continuous belt of similar country, carrying a varied insect population, and where it might be subject to attack from many quarters. Hence, one of our reasons for attempting to establish the Canadian Dexiid in the Isis district. Conditions for the liberation of this Dexiid were not however satisfactory, since drought conditions prevailed during 1931-32, and during 1932-33 host grubs were relatively scarce. It is yet premature to attempt to ascertain whether the parasite has become established or not, since very few of such initial liberations show definite results for some years, but this liberation will be watched closely and collections of grubs will be made periodically to ascertain if the parasite is actually breeding in this new locality. With regard to the time taken for a parasite to become effectively established, an extreme case is on record where a parasite introduced into America to control a certain fly pest was apparently ineffective, and was not recovered for twenty-one years after its liberation, but at the present time it is regarded as the most efficient natural controlling agent of this pest.

In the case of the "greyback" cane grub, the hope of attaining any appreciable increase in parasitism by the introduction of a foreign parasite does not appear very promising in the light of our present knowledge of the pest. This insect is indigenous to Queensland, and in its natural state the grubs fed on the roots of native grasses and other plants more especially in "scrub country." With the planting of these fertile jungle areas with sugar-cane, the greyback has been favoured with a set of conditions pre-eminently suitable for its wholesale multiplication, and it is now found in pest proportions from Mossman in the north to Carmila as its southern limit. Thus, the area covered by this pest, in contradistinction to being of the biological island type, is more truly of the continental type, and in this large expanse it is attacked by a considerable number of natural parasites, which in their turn are kept in check by hyperparasites, rendering them more or less ineffective. Hyperparasites are not, as a rule, specific, and they would in all probability turn their attentions to any new importations we might make, and render them equally impotent. Further, since there are no overlapping generations, and the period of activity of any one of the stages in the life cycle of the greyback is relatively short, it is probable that an introduced parasite would require an alternate host to maintain it throughout the corresponding period of its cycle when grubs are not readily accessible. This necessity for an alternate host is considered to be a distinct disadvantage, since the parasite would then divide its activities between two or more species of grubs, rather than concentrate on the one pest whose numbers we wish to materially reduce. However, this side of the question will be further investigated with a view to discovering any circumstances which might justify our proceeding with such a desirable form of control.

Hitherto we have dealt with biological control from the point of view of control by insect parasites, but it is well to remember that diseases often take heavy toll of dense insect populations. These diseases are, however, rather unreliable, and are usually dependent for their wholesale development upon a set of favourable weather conditions. Birds, too, are generally regarded as being of great assistance to man in keeping down his insect enemies, and one has only to watch a flock of ibises following behind ploughs and ridding the land of soil-frequenting insects to be convinced of the numbers they are able to destroy. Crows also are assiduous grub eaters, but in some seasons when food is plentiful they are somewhat diffident in following the ploughs. Other smaller birds often show a decided preference for the smaller parasites and predaceous insects, and their importance as grub destroyers appears to have been overrated in certain instances. In the West Indies, the giant toad, *Bufo marinus*, is believed to exercise a very appreciable degree of control upon the beetle stage of "white grubs." This animal has recently been introduced into Hawaii and we are watching its activities closely with a view to its introduction into Queensland.

LEGISLATIVE CONTROL.

Legislative control is preventive rather than remedial, and the institution of a strict quarantine aims at preventing the importation of foreign pests. Although most of our serious sugar-cane pests are native ones which have turned their attentions to cane, a notable exception is the sugar-cane beetle borer, which originally came from New Guinea, and we might well ask ourselves how much better off some individuals might be if they were not embarrassed by the presence of this pest on their farms. Other important pests are to be found in nearby sugar-producing countries, but these we fortunately have not yet acquired. However they remain potential sources of danger if attempts are made to evade the State quarantine regulations,

or if the indiscriminate introduction of new varieties were permitted. With the quicker modern methods of transport, and the extended use of aerial travel, the chances of foreign pests being imported into Australia appear to be considerable, despite the existence of rigorous quarantine restrictions, and if some of these pests became established our sugar industry might suffer serious losses before they could be brought under effective control. Again, some of our resident pests have not yet succeeded in becoming established throughout the whole of the sugar districts of Queensland. Whether this was due to previous unsuitable conditions, or to the happy circumstance that none of these pests were ever introduced into clean areas with the exchange of planting material, is more or less a matter of speculation at the present time. However, with the extension of irrigation in some of the drier belts, and the consequent production of larger crops, uncontrolled interchange of plants might easily result in the spread of some of these pests to areas far beyond their present limits, now that conditions in these latter districts appear to be more suitable for their establishment. To guard against any such occurrence, inter-district quarantines have been established, involving eight major districts, and a proclamation has been issued prohibiting the removal of cane for planting purposes from one major district to another, unless under permit from the Bureau of Sugar Experiment Stations. In order further to discourage the transport of varieties from one district to another there has recently been enacted an amendment to the Cane Prices Act whereby there is required to be published each year a list of the varieties which are approved for each mill district, all other varieties being automatically disapproved and subject to penalties. This amendment is intended to remove the incentive for variety fanciers to collect canes from all over the State, a practice which has already had the most serious consequences in spreading diseases to new localities.

Such laws are of little avail unless they are backed up by a well informed and well disposed public opinion. The spread of insect pests constitutes a real danger, and all growers and others interested in the welfare of the sugar industry should accord their sympathetic co-operation in the enforcement of any measure aimed at pest restriction.

Poona Pea as a Green Manure Crop in North Queensland.

POONA pea has been employed extensively in the Central and Southern cane areas during recent years, by reason of its ability to withstand dry weather and the attack of the bean fly. It has now been demonstrated that the species gives satisfactory results in the Burdekin area, while excellent crops have also been produced in the humid far northern districts. Its wider use is, therefore, recommended wherever a cover crop is required for periods not exceeding four months. Where long fallowing is practised it will be found that Mauritius bean is preferable. A satisfactory stand may be obtained by seeding at the rate of 8 lb. per acre, though from 10 to 12 lb. are more usually applied broadcast. In order to obtain an even distribution with light seeding, the expedient of mixing the seed with an equal part of dry, coarse sand is helpful. Seeded at the rate of 8 lb., the cost per acre at current market prices is only 2s. 6d., as compared with 20s. to 30s. with Mauritius bean.

H.W.K.

The Resistance of the Seedling S.J. 4 to Grub Damage in North Queensland.

DURING the past season it has become apparent that the seedling cane S.J. 4, which was bred at our South Johnstone Station, has considerably greater power of resistance to grub attack than any other variety at present being grown commercially in North Queensland. In numerous instances where S.J. 4 has been grown in the same field with Badila, D. 1135, and

FIG. 1.—Photograph illustrating the comparative resistance of S.J. 4 (left) and Clark's Seedling (right) to grub attack. The average number of grubs per stool in the two rows of S.J. 4 seen in the photograph was 6·2, while in the two adjoining rows of Clark's Seedling the average number per stool was 3·9. Photograph taken some eight weeks after the Clark's Seedling had fallen.

White Rock, Cairns. 11-5-34. [*Photograph by R. W. Mungomery.*

Clark's Seedling, the S.J. 4 has been erect and green, while the other varieties have been completely lodged and dying. An excellent comparison is illustrated in the photograph reproduced in Fig. 1; in this instance, four rows of S.J. 4 were grown on the outer edge of a field of Clark's Seedling. The photograph was taken some six weeks after the Clark's Seedling had fallen flat. In order to make certain that the better appearance of the S.J. 4 in this plot was not due to its having less grubs per stool, some twenty stools of each variety were dug up at regular intervals in the first two rows of each

plot, and the number of grubs under each stool carefully counted. The number of grubs found, and their distribution, is set out below, the asterisk marking the position of each stool excavated:—

												Total.
S.J. 4	7	4	1	7	5	5	7	2	4	7		49
	14	3	10	9	6	13	5	3	7	5		75
H.Q. 426	4	1	5	1	7	8	4	1	2	3		36
	2	9	2	2	7	3	8	4	3	2		42

The average number of grubs under each stool was, therefore, 6.2 in the case of the S.J. 4 and 3.9 in the case of the Clark's Seedling. It is a well-known fact that taller cane is more attractive to the beetles than shorter cane and, therefore, it might be expected that the more vigorously-growing S.J. 4 would have a larger grub infestation than the immediately adjacent Clark's Seedling.

Other excavations have furnished similar results, and there is no doubt that, at least under most conditions, S.J. 4 is able to withstand a considerably greater intensity of grub attack than the other standard varieties. This is of great importance, for two reasons:—Firstly, in the case of attack by a moderate number of grubs per stool, the variety S.J. 4 is able to withstand the attack to a great extent and remain upright and green, while a large proportion of the stools of other varieties lodge and die. Secondly, in the case of heavier attacks, although the S.J. 4 will eventually collapse, it has been found that, in general, it will not lodge until somewhere about six weeks later than varieties such as Clark's Seedling. This fact is of the greatest importance, inasmuch as it allows of a much longer period during which to fumigate. During the unduly wet conditions of the current season, Clark's Seedling, Badila, and other varieties had often lodged badly before the soil had dried out enough to permit fumigation to be carried out. On the other hand, the greater resistance of the S.J. 4 usually allowed of fumigation being successfully carried out long after other crops were flat.

It is obvious, of course, that resistance to grub attack can only operate effectively up to a certain point; an average of a dozen grubs per stool, for example, must rapidly bring about the destruction of any variety under the sun. Nevertheless, a variety which can withstand the attack of one or two more grubs per stool than other varieties, or which will remain erect for a longer period and so permit of late fumigation, manifestly has considerable economic possibilities. These factors will receive close consideration in the future testing of seedlings which are raised at the Meringa Experiment Station.

In planting S.J. 4 it should be remembered that it is a late-maturing variety, and hence, in order to obtain satisfactory results, it should be planted during the early (or autumn) planting season. For the benefit of those growers whose farms are situated in districts where gumming disease is present, it should also be stated that this variety is the most susceptible variety known, in so far as gumming disease is concerned.

A.F.B.

Disease Resistance Trials.

By ARTHUR F. BELL.

ALL cane varieties which are introduced from abroad by the Bureau, or seedlings raised on the Experiment Stations, are planted out in disease-resistance trials in order to indicate how they will behave if exposed to the diseases of any particular district. When forearmed with this knowledge, it is possible to forecast accurately the subsequent behaviour of most varieties, and so avoid the economic losses which result from rapidly propagating a promising variety, only to find that after a few years it is wiped out by one of the diseases common to the district. In this respect the variety P.O.J. 2878 is an interesting example. Owing to the wide publicity given this variety, the demand for plants by Queensland growers was so insistent that the then Director was compelled to distribute this cane before it could be adequately tested for resistance to any disease, excepting only gumming disease. As a result, considerable areas were planted before resistance trials could be completed and, doubtless, there are now many farmers in North Queensland who wish they had never heard of the cane.

For the information of farmers we include in this short article the results of red stripe resistance trials for 1933 and 1934, and results to date of a downy mildew trial which will be harvested this year. It should be pointed out that these trials are so arranged that the conditions favour infection as much as possible, so that we can obtain in one year results which would perhaps take four or five years to obtain under field conditions.

RED STRIPE (TOP ROT) DISEASE.

In these trials the cuttings of the varieties under test are planted late in the season and crowded close together; the plots are heavily fertilized, and every third row is a highly susceptible variety which will provide a constant source of infection. Results from two trials conducted in 1933-34 are summarised in the following table:—

Variety.	Total Stalks.	Dead Stalks.	Per Cent. Death, Approximate.
Q. 4D	144	0	0
Q. 1D	221	1	0·5
P.O.J. 234	178	3	2
P.O.J. 2725	197	5	2·5
H.Q. 426	210	7	3
Oramboo	201	8	4
P.O.J. 2747	127	6	5
S.J. 4	128	9	7
Badila	205	23	11
Q. 3D	151	25	16·5
Q. 2D	160	30	19
P.O.J. 2878	905	170	19·
P.O.J. 2940	177	34	19
P.O.J. 2727	116	32	28
P.O.J. 2714	123	46	37

In addition, in the varieties P.O.J. 2722 and P.O.J. 2875, which did not produce 100 stalks, death occurred at the rate of 22 per cent. in each case.

Field experience has shown that varieties which are more susceptible than Badila are likely to suffer considerable losses, especially when planted late in the season. It is evident, then, that the seedlings Q. 2D and Q. 3D and the P.O.J. varieties 2878, 2940, 2727, 2714 (and probably 2722 and 2875) are too susceptible to be grown in districts where red stripe top rot is prevalent unless they possessed other very outstandingly favourable characteristics. It is pleasing to note that the variety P.O.J. 2725 has shown such satisfactory resistance. The seedlings Q. 4D and Q. 1D are unnamed seedlings which are still under observation and trial.

DOWNY MILDEW.

In this trial, which was planted in March, 1933, diseased sets of B. 208 were planted throughout the plot. The cane is now lodged and tangled, and it will be impossible to make a further estimation of the amount of disease until the crop is harvested. In the last counts, which were made at the end of October, the following percentages of disease were recorded:—

Clark's Seedling	Nil
P.O.J. 2725	Nil
P.O.J. 2878	25 per cent.
Badila	Nil
B. 208	15 per cent.
P.O.J. 2940	85 per cent.

As a result of this trial, it has already become obvious that P.O.J. 2940 and P.O.J. 2878 cannot be considered as suitable for the Lower Burdekin district, a conclusion which is backed up by a considerable amount of field experience in the case of P.O.J. 2878. The performance of P.O.J. 2725, however, is very encouraging to date, and good things are expected of this cane. Further promising varieties have been included in a trial which was planted in March of this year.

Permits Necessary for the Transfer of Cane Plants.

FARMERS are again reminded that the State has been divided into several Sugar-cane Quarantine Districts, and that a written permit must be obtained from an Inspector under the Diseases in Plants Acts before cane for planting purposes is transferred from one district to another. The boundaries of these quarantine districts correspond approximately to lines drawn east and west through the following places:—(1) Cardwell; (2) Townsville; (3) Bowen; (4) Alligator Creek (south of Mackay); (5) Rockhampton; (6) Howard; (7) Hook Point (on the south of Great Sandy Island); (8) Brisbane.

In addition to these general quarantine districts, local quarantines have been declared in the Millaquin and Maryborough mill areas for the control of Fiji disease, and removal of cane from these areas is prohibited. All requests for the inspection of cane for the purpose of obtaining a permit must be lodged with the Director, Bureau of Sugar Experiment Stations, Brisbane, not later than 15th July.

New Cane Varieties in the Southern Districts.

By H. W. KERR.

SOME six years ago a comprehensive project was undertaken with a view to supplying the growers in the gum-stricken cane areas of Southern Queensland with new varieties possessing the following qualifications:—

(1) High resistance (or practical immunity) to gumming disease.

(2) Vigour of growth and drought resistance.

(3) Good ratooning qualities.

(4) Satisfactory sugar content.

With this end in view a wide selection of canes was imported from overseas, and placed first of all in gumming resistance trials. Those varieties which did not possess the desired degree of resistance were immediately discarded; those selected as satisfactory were again submitted to disease trial; and those which displayed high resistance, combined with growth vigour, were set out in propagation plots, from which a sufficient supply of cane would be obtained for yield trials. Six promising varieties were thus established on the Bundaberg Experiment Station in 1932, and the yields of the plant crops were recorded in the Director's Annual Report of 1933. Although the growing conditions during the period were far from favourable, five of the varieties produced crops greatly in excess of that from the standard, Q. 813. Of these, Co. 290 and P.O.J. 2725 appeared particularly promising, and their yields were as follows:—

	Cane per acre. Tons.
Co. 290	22.8
P.O.J. 2725	16.8
Q. 813	9.3

The canes were approximately eleven months old when harvested. In the ratoons, these two varieties have shown remarkable growth. The crops have been estimated at from 35-40 tons per acre, while the standard Q. 813 will yield less than 20 tons. The present appearance of the crops may be gathered from the accompanying illustrations, which were obtained in May, 1934:—

FIG. 2.—VIEW OF PLOTS IN THE VARIETY TRIAL AT THE BUNDABERG EXPERIMENT STATION (First Ratoon Crop).

The characteristics of these canes, so far as is known, are entirely favourable; they possess the desired high degree of resistance to gumming disease, are marked drought-resisters, good stoolers, and vigorous ratooners. They are low in fibre, and of satisfactory sugar content. Further data on the c.c.s. content and time of maturity are being obtained at the present time, and early results indicate that P.O.J. 2725 is rather early maturing. In comparative tests at Mackay last season, this cane was found to mature earlier than did Q. 813, and the final c.c.s. value was equal to that of the latter. It also appears to ratoon well when cut early in the season.

FIG. 3.—SHOWING ADJACENT PLOTS OF CO. 290 AND Q. 813, FIRST RATOONS.

In 1933 the crop harvested from the Experiment Station was planted out in farm yield trials and propagation areas. Again the canes have shown up very favourably under a wide range of soil conditions, and it is anticipated that about 100 tons of each variety will be available for further plantings in centralised plots, with a view to widespread distribution in 1935.

Co. 290 has performed remarkably well on the wet lands of the Maroochy district. In a particularly wet season the cane has given excellent results where other varieties have failed; and should the results of the maturity tests which are being made on samples from the block prove satisfactory, growers in this area will be supplied in 1935 with adequate stocks of a most valuable cane.

For those growers who are prejudiced against Co. varieties because of the unfavourable characteristics of Co. 210, 213, and 227, it should be pointed out that Co. 290 is of different parentage, and produces a cane of good barrel. It is fully anticipated that the cane may be harvested unburnt.

Co. 290 and P.O.J. 2725 should also prove valuable canes for certain of the Mackay lands, and the wide propagation of these varieties is being undertaken with this end in view. Certainly one or the other should prove superior to P.O.J. 213. With regard to P.O.J. 234 (which is closely related to 213, but which is a reputed early maturer), it is probable that the usefulness of this variety will be limited by reason of its high susceptibility to mosaic disease. In areas where this disease is widespread, it will not be possible to retain the variety in a disease-free condition.

Experiments with White Arsenic as a Means of Controlling Grubs.

IN the first issue of the Quarterly Bulletin (1st July, 1933), it was stated that some six experiments had been set out in the Lower Burdekin district in order to obtain some definite evidence regarding the value of applying white arsenic to the soil as a method of grub control. In addition, the Invicta Cane Pests Board laid down a further trial in the Yuruga district, but in this case the arsenic was applied to late-planted cane.

Naturally the arsenic has to be applied at or about the time of planting, and the question of whether an adequate infestation of grubs will be obtained in the experimental plots is purely a matter of chance. In these particular cases chance did not favour the experiments, and in only one trial were there sufficient grubs to enable comparisons to be drawn. Arsenic was applied in the drill after planting, at the rate of 80 and 200 lbs. per acre.

From an examination of these plots and excavation of stools on other fields where arsenic had been applied it was quite evident that the application of the smaller amount of arsenic was useless. As far as the application of 200 lbs. per acre is concerned, this appears to have some value where the infestation is light, but its value with a heavy infestation of grubs is very doubtful. At the request of Invicta Cane Pests Board six further trials have been laid out by Mr. Buzacott on farms in the Ingham line district; varying amounts of arsenic have been used and the method of application has been varied in some of the experiments. As these trials have all been put out in fields of early plant cane it is hoped that the infestation will be satisfactory for the purpose of the trials.

In conclusion, it must be said that the value of applications of white arsenic as economic means of grub control is doubtful, and its use certainly cannot be recommended at this juncture. For the benefit of those who may intend using this poison, a warning is issued that it should not be applied on a windy day, as the fine powder may cause painful burns on the face.

A.F.B.

Control of Cane Grubs in North Queensland by Fumigation.

By H. G. Knust.

AMONG the insect pests of sugar-cane in North Queensland the grub of the Greyback Beetle, *Lepidoderma albohirtum*, is of outstanding importance. This grub, on account of its wholesale destruction of the roots of the growing cane during January-April, is annually responsible for many thousands of pounds' worth of damage to crops. In order to reduce such losses several methods of control have been developed, but it is the purpose of this paper to deal only with the killing of the grubs by the injection of fumigants into the soil. The properties of a large number of fumigants have been investigated by entomologists, but unquestionably the most effective so far employed consists of paradichlorbenzene dissolved in an equal weight of carbon bisulphide. This fumigant, properly applied, has proved a most efficacious form of control, and this paper is based on its successful operation on a large scale in the Tully area. While this success is primarily to be attributed to the fumigant in question, it must be pointed out that attempts to control the cane grub, whatever the method adopted, will be doomed to failure unless carried out in a carefully planned and methodical manner. The salient features of such a plan and the methods employed will here be discussed.

WHERE AND WHEN TO FUMIGATE.

Before attempting fumigation, fields should be searched systematically for grubs, and a correct record kept of the grubs found and their distribution; haphazard searching and recording ultimately proves costly and most unsatisfactory. This search, or inspection, consists in turning up and thoroughly examining the soil on either side of selected stools, commencing in the centres of the interspaces and working inwards to the edge of the stool. Searching should be commenced from the outer edge of the field, making the first inspection on a stool half a chain from the headland in the fifth or seventh row, and thence on stools one chain apart for the entire length of the row. After completing the row this procedure is repeated in every fourteenth row until the inspection of the field has been completed. By this means it is possible to determine whether the grubs are sufficiently numerous to justify fumigation and whether correctly situated to warrant immediate treatment. It is never necessary to remove the stool when searching for first or second stage grubs.

The best method of keeping a record of the grubs found is to make a plan of the field and record their relative positions; such a plan is illustrated in Figure 1. An average of three or more grubs per stool makes fumigation absolutely necessary; by the use of this method the distribution of the grubs can be seen at a glance, and it can readily be determined whether the whole or only part of a field requires treatment, thereby effecting a considerable saving as compared with haphazard searching and recording. In the case illustrated in Fig. 4 (which represents an actual inspection), the shaded portion of the field was fumigated, while the other portion remained untouched. Control by this method proved entirely successful, no appreciable loss resulting in the unfumigated portion. If a method such as the one outlined had not been adopted the whole field would possibly have been treated or some doubt would have been felt as to whether fumigation was warranted or not.

The time of application of the fumigant will naturally depend on the time of emergence of the beetles for mating. The beetles lay their eggs more or less indiscriminately, and sometimes in the inter-spaces, consequently a period of time must elapse before the resultant grubs become concentrated below the stools, where successful fumigation demands that they should be. Some seven weeks after the major beetle-flight usually finds the big majority of the grubs in their second stage and suitably situated for effective treatment. Another factor governing time of fumigation is weather, as the

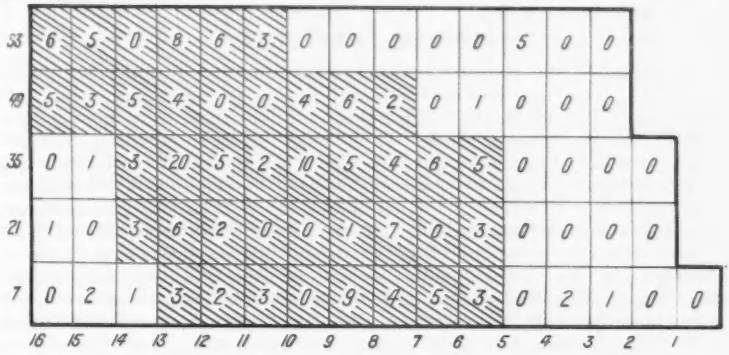


FIG. 4.—PLAN SHOWING DISTRIBUTION OF GRUBS IN CANEFIELD.

weather conditions prevailing at the time of fumigation play an important part in determining the efficacy of the operation. Should the soil be too moist or too dry only those grubs situated close to the fumigant will be destroyed. Particular attention must accordingly be paid to the condition of the soil before applying the fumigant; excessively moist soil prevents the diffusion of the fumigant, while very dry soil allows the lethal vapours to escape to the atmosphere. The heavy alluvial soils are inclined to remain too moist for fumigation for a greater period than the volcanic or other well-drained soils, while, with the advent of a dry period, the better drained soils soon become too dry, and failure results if fumigation is continued.

QUANTITIES OF FUMIGANT AND METHOD OF APPLICATION.

When the cane stools are of normal proportions and the row inter-spaces are 5 feet, approximately 160 lb. of the mixed fumigant is required to fumigate 1 acre. This quantity must necessarily be increased when the stools are exceptionally large, or the interspaces less than 5 feet. For mixing large quantities, a 44-gallon petrol or kerosene drum with the top removed is most suitable. Mixing should be done late in the afternoon, and the fumigant left in the mixing vessel overnight, thereby allowing the carbon bisulphide to dissolve the paradichlorbenzene completely. Evaporation is effectively prevented by covering the vessel with wet bags. When only small quantities of, say, up to 5 gallons, are required, the mixture can be prepared ready for use in about thirty minutes. Before using the fumigant it is most important that it be strained, preferably through hessian fitted over a funnel, in order to remove solid particles; in this way annoying delays due to clogging of the injector are reduced to a minimum.

The most favoured method of application of the fumigant to the soil is by means of the manually operated "Dank's" injector, because by this means the injections can be placed in the most suitable positions alongside

or, when necessary, between the stools. Provision for the regulation of the required dose is made by a socket situated at the top of the fumigant container. The setting of this regulator will vary according to the type and tension of packing used in the gland at the container's base through which the plunger rod passes. By setting the regulating socket in the second and third position from the base, a 4 to 4½ ccs. dose should be obtained. White hide or green hide is the most suitable material for both packing-strips and washers. The depth to which the injections are made (usually 4 to 4½ inches) is controlled by a movable footstep attached to the driving point or spike of the injector.

COSTS OF FUMIGATION.

Since, as a rule, the time of fumigation coincides with the wet season, it is usual to apply the fumigant in doses of 4 to 4½ ccs., which are injected at a depth of 4 to 4½ inches alongside the stools with a distance of approximately 12 inches between them. This dosage is the most economical since smaller ones require considerably more care in application and larger ones are unnecessary. Where the 4½ ccs. dose is used, the cost of the fumigant is £6 per acre, and, allowing the operator three days in which to cover that acre (an average performance which costs £2 8s. for labour), the total cost of fumigating 1 acre is then £8 8s. To some this cost may seem excessive; actually, it is only the price of a few tons of cane. Successful fumigation, besides saving from grubs more than the few tons of cane required to cover the amount expended, eliminates the necessity of ploughing out and replanting fields which should be producing profitable ratoons. For example, one grower in the Tully area, who was harvesting 1,500 tons of cane per annum before the introduction of the fumigation campaign, has since then produced an average of 3,000 tons per annum during the past three years, by fumigating all infested areas. Furthermore, instead of ploughing out and replanting a large proportion of his crop each year, he is now enjoying the benefits of ratoon cane.

Care of Farm Machinery.

A CAREFUL observer is forced to the conclusion that rust is the implement manufacturer's best friend. Frequently, one sees valuable field machinery standing grass-covered and exposed to the weather which soon destroys the protecting paint, and rapid decay follows. The prudent farmer realises the value of caring well for his implements, and endeavours to keep them under cover when the seasonal work is over. He greases the soil-wearing parts, repairs any small items which require attention, and frequently gives the framework a fresh coat of paint. He removes the residual fertilizer from his manure distributor box as soon as this work is finished. Many of these duties are conveniently carried out as wet-weather jobs, and the farmer who cares for his implements knows the value of the time bestowed upon them, both in prolonging their useful life and reducing operating costs.

A.P.G.

Ratooning in the Burdekin District.

By A. P. GIBSON.

DURING recent years farmers in the Burdekin district have been paying more attention to the problem of ratooning, with the result that many growers are now producing ratoon crops which compare favourably with the tonnage of the preceding plant cane; this is particularly true if due allowance be made for the reduced growing period enjoyed by the ratoon crop. But there are still many farmers who are not able to produce successful ratoons, and the following criticisms and suggestions are put forward in an attempt to help them in their difficulties. They are based on careful observations extending over the past five years.

When the writer first visited the Burdekin area, the only ratooning method was that of "volunteering"; that is, after the plant cane was harvested, the field was untouched, and the young ratoon shoots were left to force their way through the heavy mass of trash and tops, and to subsist without irrigation water or fertilizer. In a favourable wet spring, the results were moderate, but in a normal season very little ratoon cane was produced under this system. As a result, most growers produced only plant cane, after which the land was fallowed in preparation for replanting. At the present time a conscientious attempt is being made to provide better conditions for the ratoons, but certain features of the customary practice even now call for substantial modification.

Undoubtedly the harvesting methods employed are not in the best interests of successful ratooning. With a daily or weekly allotment throughout the harvesting season, the fields are bared too slowly of their crops, with the result that the stubble is covered overlong with a heavy bed of crop residues; when these are subsequently removed by burning, many of the ratoon shoots are so far advanced that they are seriously checked if not entirely killed. After burning off, the field is frequently left uncultivated for a long period, and the hard bare surface is baked and depleted of its moisture. Again, many growers are attempting to farm larger areas than they can manage; and while the plant cane receives the attention it requires, the ratoons are sadly neglected. It should be remembered that a small area well-tended is better than a larger area which is partially neglected. In a less degree, ratoon blocks are also affected by "gappy" stands, following on an indifferent strike in the plant cane. These gaps result in excessive weed growth, are costly to keep clean, and result in reduced yields per acre.

For better ratoon crops it is of paramount importance to start the new crop early and well, so that full advantage may be taken of the optimum growing conditions of the summer months. The trash should be burned within two weeks of harvesting, and the area burned at any one time should not exceed the area which the grower can immediately cultivate effectively. The first cultural operation should be a thorough discing; this loosens the surface soil while still moist, breaks down the mounds of earth which were created in "hilling-up" the plant cane, and tends to damage the uppermost eyes of the stubble which would otherwise germinate first of all, and produce shoots which would never thrive. This latter feature is a most important consideration in successful ratooning; the encouragement of the stronger and deeper shoots will inevitably result in sturdier and thriftier ratoons.

Should the soil be dry, an immediate watering should be given; as soon as the land is in fit condition, the soil of the interspaces should be loosened deeply and well with a grubber or subsoiler. This will ensure free root penetration by the young ratoons, thus aiding them in their search for food and

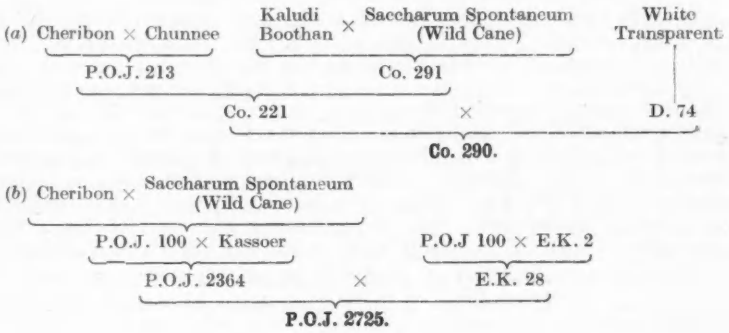
moisture. The next operation, which should follow immediately on the grubbing, is the application of 400 lb. per acre of a suitable mixed fertilizer, placed alongside the cane row at a depth of 3 or 4 inches. An early application of 200 lb. of sulphate of ammonia per acre will also ensure a good supply of available nitrogen—the plantfood in which the Burdekin soils are particularly lacking. If this first application of sulphate of ammonia is buried on the opposite side of the row from the mixed manure—or applied with the latter if this be preferred—undue weed growth while the ratoons are young will be largely avoided. In the formation of subsequent water furrows care should be taken not to turn the fertilizer away from the cane row to the interspace. The young crop requires its food early, and this must be kept close to the feeding zone of the young root system.

Some 6-10 weeks later, the ratoons should again be top dressed with sulphate of ammonia, in similar amount to the earlier dressing. The grower should remember that ample soil moisture must be maintained at all times, and it is particularly important that the crop should suffer no growth check after it has begun to make cane. Fertilizer also will produce beneficial effects only if the soil is moist enough to dissolve it.

Group harvesting would undoubtedly help materially in the rapid harvesting of blocks, and in enabling the grower to press on with his ratoon cultivation while the harvesting gang were engaged elsewhere in the group. The increase in crushing rate which the local mills have shown during recent years will also make for a shorter harvesting season, and this also will be reflected in the success of ratoon crops.

The Parentage of P.O.J. 2725 and Co. 290.

In view of the promise shown by these two new varieties, the parentage of each is appended for the information of growers. It will be seen that P.O.J. 2725 is of the same parentage as P.O.J. 2878, the "wonder cane" of Java, and that both P.O.J. 2725 and Co. 290 have wild cane as one great grandparent.



Cane Borers in the Mackay District.

By W. A. McDOUGALL.

THE presence of borers in sugar-cane has often been reported in the Mackay district. "Borer damage" is caused by two quite distinct species of insect, and it is important that farmers should be able to distinguish between the two, so that there will be no confusion as to the identity of the insect concerned when such reports are received. These two borers are the Beetle or Weevil Borer and the Large Moth Borer. The former is common in the areas north of Townsville, and any references to borers in that part of the State usually concern the Beetle Borer, while in the Mackay district the Moth Borer is the much more prevalent pest.

The larvæ or caterpillars of the moth borer tunnel into and eat the centres of young shoots of both plant and ratoon cane, causing the central shoots to die and give rise to "dead hearts." Upon splitting open such shoots the light-purplish caterpillars are found, and at this stage they are usually about one inch in length. These dead hearts may be rather conspicuous in a field of young cane, but the damage is very much less than might at first be supposed. Even in the absence of any pests or diseases up to 60 per cent. of the shoots produced in a field die before forming cane, and so, to a great extent, the moth borer merely effects a thinning out which would take place in any case. We very rarely observe an infestation which is severe enough to result in a weak stand of cane (even in small patches) such is caused by attacks of wireworms or *Rhyparida*. The caterpillars also bore into standing cane, but in such instances, provided the field has been kept reasonably clean, the attack is mainly confined to cane adjacent to the headlands. Last year we received a report concerning some fields of standing cane, which appeared from the headlands to be fairly badly attacked. On traversing these fields, however, it was found that the damage was almost entirely confined to a border extending about 1 chain inwards from the headlands; in this zone the infestation was 8.4 per cent. of the stalks, while within the field it was negligible. A careful investigation of the situation by sampling and analysis revealed that the total loss from borers in these fields was less than one half-penny per ton of cane. Although grassy fields usually carry the heaviest infestation, damage is rarely significant, and the moth borer is generally considered to be a minor pest in the Mackay district.

The weevil borer has at various times been reported from all the older cane areas around Mackay, and also from the newer lands of the North Coast and Carmila. After a succession of wet years the softer varieties of cane may suffer appreciable damage by this borer in certain parts of the district, but with the return of the more usual climatic conditions the numbers rapidly decrease, and the borer can only be found in an odd stalk here and there. The adult weevil is a dark-brown insect about half an inch long. It bores a short tunnel through the rind of the cane into the juicy flesh with its curved beak-like head, and deposits an egg at the bottom of the tunnel. The larva hatches out, and in a few weeks develops into a creamy white grub with a reddish head, its total length being about one-third of an inch. This grub tunnels through the cane stalk, destroying the stalk tissues and allowing the entry of the red rot fungus and other parasites. Before pupating, the grub constructs a peculiar cocoon made of cane fibres compactly interlaced, and generally situated near the rind at the end of a tunnel.

In Hawaii, Fiji, and the wet belt of North Queensland, the introduction of the Tachinid fly, a natural parasite of the weevil borer, has greatly reduced the amount of borer damage. In the Mackay district, however, the percentage of stalks infested in any field is seldom as great as that experienced in other

places after the Tachinid fly has reduced the infestation to a minimum. It is likely, therefore, that very great difficulty would be experienced in establishing sufficient numbers of the fly in the district to enable it to control the occasional moderately heavy infestations, but liberations of these flies were made on selected farms last year, and further supplies will again be made available during the coming harvesting season. There seems to be little doubt that climatic conditions have prevented this borer from being a serious pest, and will continue to do so.

Early Effects of Fertilizer.

THE Bureau always recommends the early application of manures in order that their full benefits may be realised. The wisdom of this policy is clearly in evidence in many of the farm fertility trials set out by the Bureau each year. It is a well-known fact that early applications of phosphate lead to rapid early development of the young roots and shoots; and the influence of this plantfood may be observed frequently when the crop is but a few weeks old.

The accompanying illustration (Fig. 5) was obtained on the red forest soil of the Bundaberg area during the past autumn planting season. The cane

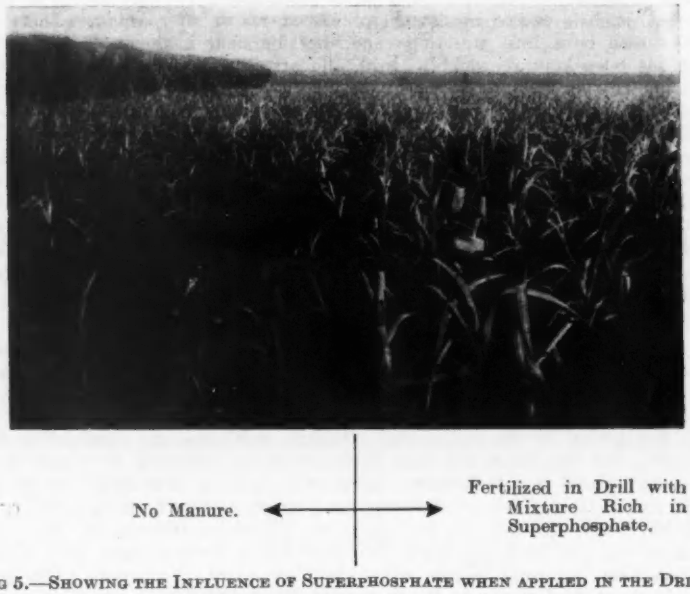


FIG 5.—SHOWING THE INFLUENCE OF SUPERPHOSPHATE WHEN APPLIED IN THE DRILL, ON THE EARLY VIGOUR OF THE CROP. PLOTS ON RED FOREST LOAM.

on the left of the picture had received no manure, while that to the right had been fertilized in the drill with a mixture rich in superphosphate. The importance of drill fertilization to promote rapid early growth in autumn-planted cane cannot be over-emphasised, if a well-developed crop is desired before the winter months. For the phosphate-deficient forest soils, this applies with particular force. G.A.C.

Some Notes on Weed Killers.

KNOWING that "one year's seeding gives seven years' weeding" most growers will agree that the best method of weed control is intelligent cultivation. But it will also be admitted that occasions frequently arise when weed-killing sprays can be of great use to the farmer even though the seeds of plants are seldom killed by them. The following notes and formulae concerning sprays have been gleaned from the literature on the subject and are not the result of actual experience. They are intended, therefore, only to serve as a guide to growers intending to experiment with sprays and are not to be taken as specific recommendations.

Weed sprays may be divided into three principal classes, namely—(*a*) oils, (*b*) arsenicals, and (*c*) other chemicals, and in that order we will briefly discuss them.

(*a*) **Oils:** Mineral oils have been used with considerable success on certain American and Hawaiian estates where the cost of material is low. Crude Diesel oil is the type generally used. In the event of customs duties on this material being removed or considerably reduced, it might profitably be used in Queensland on occasions where arsenical sprays prove too dangerous to stock. It may be applied either by a pressure sprayer or a knapsack sprayer, the latter being more suitable where heavy weed growth has occurred.

(*b*) **Arsenicals:** The two forms of arsenic commonly used as weed killers are Sodium Arsenite and Arsenic Pentoxide.

Sodium Arsenite: Prepare as follows:—13 lb. of white arsenic are mixed with 1 gallon of water, 7 lb. of caustic soda are added and the mixture thoroughly stirred and, if necessary, heated to assist solution. When completely dissolved another 1 gallon of water is added. This mixture serves as a stock concentrated solution. For use, from half pint to 1 pint of concentrate should be added to 5 gallons of water, the quantities depending upon the hardiness of the weeds to be killed. From 20 to 30 lb. of arsenic are needed per acre. Washing soda may be used for making up this mixture, in which case 26 lb. of soda are used instead of 7 lb. of caustic soda, and boiling is necessary.

In Hawaii this mixture is recommended especially for irrigated land where mechanical cultivation is difficult and for inaccessible places.

Arsenic Pentoxide: (Prickly-pear Land Commission, 1934). Make up a solution in water containing from ¼ lb. to 1 lb. of arsenic pentoxide per gallon according to hardiness of weeds to be killed. A copper vessel should be used for the purpose. Apply with pressure sprayer or knapsack sprayer.

Precautions to be adopted with arsenical sprays:—Owing to the poisonous nature of arsenical sprays every care must be taken to avoid injury to the operator and to stock. The addition of a dye such as Rhodamine B (1 oz. to 10 gallons of mixture) or Methylene Blue will indicate where spraying has been carried out and also act as a danger signal. Burns from the caustic soda mixture should at once be treated with vinegar. The application of petroleum jelly to exposed parts serves as an added precaution. Care should also be taken to avoid spraying sugar-cane as well as weeds; a funnel-shaped shield fitted around the nozzle of the sprayer helps to confine the spray to where it is needed.

(*c*) **Other Chemicals:** *Sulphuric Acid*—Make up a 2 per cent. to 10 per cent. solution of commercial sulphuric acid in water. When preparing such a solution always add the acid slowly to the water, *never* the water to the

acid, and always keep the water stirred while making the mixture. Mixing vessels, when made of metal, should be well coated with pitch before using; the addition of about 1 part of lanoline to 15 of pitch helps to prevent the pitch from cracking.

Solutions of sulphuric acid are naturally very corrosive to spraying apparatus and to clothes, and consequently only lead-lined sprayers should be used. Before starting operations the face and hands, and also the outside of the sprayer, should be well coated with petroleum jelly. A supply of clean water should be kept on hand so that the operator can wash the acid from his skin when necessary. The strength of the solution used as a spray will depend on the nature of the weeds and on their age—older weeds require a larger quantity of acid. Sulphuric acid sprays have been found successful especially in regions of low humidity.

Chlorates.—Both sodium chlorate and calcium chlorate have been used successfully in the control of weeds. Their principal drawbacks are cost and the fact that clothes and vegetable matter become highly inflammable when dried if they have previously come into contact with chlorates. This may largely be overcome by adding calcium chloride to the spray. The operator should change his clothes in the middle of the day and rinse them well in water each time they are changed; smoking should, of course, be avoided until a change of clothing has been effected. The strengths of solutions usually employed are:—

Sodium chlorate—10 per cent. to 15 per cent.

Calcium chlorate—15 per cent. to 20 per cent.

The sodium chlorate is usually rather more effective than the calcium salt but it is also more inflammable. The following mixture has been found successful on at least one Hawaiian plantation:—

Sodium chlorate—15 lb.

Calcium chloride (flaked)—15 lb.

Water—45 gallons.

Apply at the rate of 4½ gallons per 50 sq. feet.

The addition of calcium chloride not only reduces fire risks but on account of its hygroscopic nature, attracts moisture to the leaf surface, thereby facilitating the absorption of the chlorate by the plant. On the Hawaiian plantation in question, this mixture proved effective in killing Johnson grass on non-irrigated lands; two or three sprayings are usually required for this weed. The efficiency of chlorate sprays is increased by making them slightly acid and also by the addition of a spreader. This may be done by adding ¼ teaspoonful of sulphuric acid and 1 tablespoonful of a strong solution of glue per gallon of spray. Spraying in most cases needs to be done twice, an interval of three weeks elapsing between the two occasions. Chlorate sprays are said to be most effective during dry weather and when the weeds are approaching maturity.

Spraying Equipment.—Knapsack sprays may be obtained from Brisbane warehouses at approximately the following prices, f.o.r.—

Brass—£3 8s.

Lead-lined—£4 1s.

When estimating the costs of a spraying programme it should be realised that only the succulent and thin-skinned annuals and biennials will be killed by a single spraying. The tougher species need two sprayings and if rain intervenes, even three may be necessary.

W.C.D.

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